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ORIGINAL ARTICLE

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Posterior endoscopic discectomy (and other procedures)

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Abstract Percutaneous approaches to lumbar discectomy were somewhat controversial, because of their limited indications. They have not proven to be as effective as standard open lumbar disc surgery, because of longer operating times and some technical problems in addressing all the different aspects of lumbar disc herniations. New percutaneous posterior procedures for lumbar disc disease have been described in the last few years, but the MicroEndoscopic Discectomy (MED) introduced by Foley and Smith in 1997 seems to be the most promising one. MED, and METR'x which evolved from it, . allow the surgeon to address not only contained lumbar disc herniations, but also free-fragment disc pathology and symptomatic lateral recess stenosis secondary to bony hypertrophy. The surgical technique is summarized and some preliminary clinical results of a prospective multicenter study with 13 months' mean follow-up are presented.

Key words Disc herniation · Posterior approach · Microdiscectomy · Endoscopic approach

Introduction

Percutaneous approaches to lumbar discs by a posterolateral entry-point date back to 1964, when the use of chymopapain to obtain nucleolysis in humans was first reported [14]. Percutaneous lumbar nucleotomy by the same approach using manual instruments was subsequently introduced, in 1975 [8]. In the ensuing years, percutaneous lumbar disc surgery evolved to include the use of automated disc removal devices [11], spinal endoscopy [13], and the laser [3], always addressing the center of the disc by that posterolateral or para-foraminal route. Although good results have been achieved with each of these methods in individual cases, they have not proven to be as routinely effective as standard open lumbar disc surgery, especially when a bony or ligamentous pathology is associated with the discopathy. In selected series, the reported average success rates of various percutaneous discectomy techniques have ranged between 70 and 80% [10, 12], and a multicenter analysis of percutaneous discectomy found even poorer results (only 55%) [9]. The indications for these procedures have generally been limited to contained lumbar disc herniations, because lumbar radiculopathies secondary to large, free-fragment (noncontained) disc pathology and any kind of bony compression of the nerve root are still specific contraindications to percutaneous lumbar discectomy. Furthermore, the clinical results with these techniques are not at all far from those obtained by any specific and correct conservative treatment.

In the early 1980s, following the technique and the instrumentation described by Caspar [2], there was a progressive diffusion of the use of a microscope for disc herniation surgery. This has permitted a less invasive approach than the open one, with a shorter postoperative recovery of the patient. This technique is still widely used, and it is now the "open" technique for lumbar disc surgery to refer to (the "gold standard").

Nevertheless, the idea of a percutaneous, even less invasive approach to lumbar disc disease remained appealing. Some years ago, a new instrumentation for the percutaneous posterolateral foraminal approach was described

by Hallett Matthews. The so-called Microendo system allows the use of micro-instruments through a tube, making it possible, under endoscopic control, to perform a true discectomy combined or not with laser nucleotomy. Similarly, Fontanella in Italy began to use a transforaminal approach for endoscopic disc surgery, using "working sleeves" [7]. But those are always lateral approaches, which often make it hard to work into the canal, and would therefore require a separate posterior surgery, should an open conversion eventually be necessary.

Meanwhile, the advances in optics and instrument design have led to the successful application of less invasive surgical principles to the abdomen, the thoracic cavity and several joints (knee, shoulder, wrist), where the surgical efficacy is at least similar to that of the conventional, more invasive approaches, but with decreased hospital stays and shorter recovery times.

With these criteria in mind, some surgeons have tried to combine the less invasive microsurgical technique by the traditional midline posterior approach with modern endoscopic technology. They have developed new systems for endoscopic posterior discectomy, either by a conic "free-hand" working channel (the Endospine by J. Destandeau [4]) or by a tubular retractor [the MicroEndoscopic Discectomy (MED) System], introduced by Foley and Smith in 1996, with a preliminary series at the end of 1997 [5]).

The latter technique has the same goal as any conventional open or mini-open lumbar discectomy (to decompress the affected nerve root), accomplished by applying standard, time-tested midline posterior surgical techniques, but under endoscopic visualization and through a small tubular retractor. It appears to be very versatile and complete, with a high success rate, and it is still in constant evolution and improvement (METR'x system).

With this true endoscopic "thru-a-tube" surgery, it is possible to perform the successful removal of disc and/or bony pathology that is compressing the nerve root, like in open approaches, but with a small skin incision and less disruption of the fascia and the paraspinous muscles, which reduces, at minimum, any postoperative backache. For these reasons, METR'x greatly lowers the average hospital stay for routine lumbar discectomy, and in some conditions it could be an out-patient procedure.

For the last 2 years the authors have chosen METR'x for their lumbar disc or canal surgery. The experience of an 18-months prospective multicenter study with this technique proves that it is at least as effective as any conventional open or microsurgical lumbar discectomy, while allowing patients to return to activity (and work) much sooner and with less pain [1].

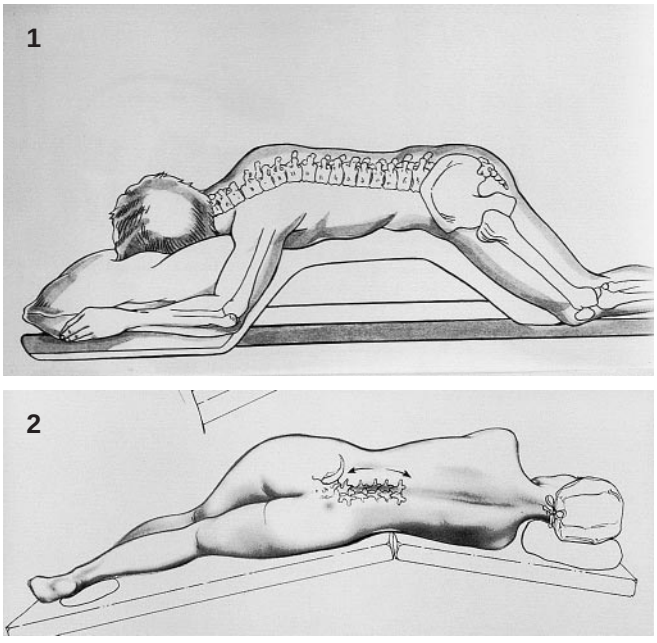

Fig. 1 The traditional prone position on the Wilson frame

Fig. 2 The lateral position, with the pathologic side upwards

Surgical technique

Anesthesia and patient positioning

METR'x can be performed under regional, or general anesthesia. We think that general anesthesia is preferable in the first period of experience, and still advisable in anxious patients or difficult cases, when an eventual open conversion may be required.

Some authors prefer the use of epidural anesthesia. This technique avoids the side effects of general anesthesia (such as postoperative nausea), and it is typically used for out-patient procedures. Generally, it is performed through an epidural catheter, placed in an upper lumbar interspace, allowing the anesthesiologist to redose the patient during surgery, if necessary.

The typical and more common patient position is prone, with the abdomen free and the spine flexed to open the interlaminar space (i.e., on the Wilson frame) (Fig. 1), but the authors prefer a true "genu-pectoral" position, with the hips and knees well flexed, which maximally reduces the lumbar lordosis and avoids even minimal abdominal vessel compression. Another position that the authors frequently use, particularly in cases of epidural anesthesia, is the lateral one (Fig. 2). It was introduced some decades ago by the Italian Orthopedic School, and it is very comfortable for the patient as well as for the surgeon, who works in a sitting position. The only disadvantage is that in case of open conversion, the patient must be turned to a prone position, to allow the use of a microscope.

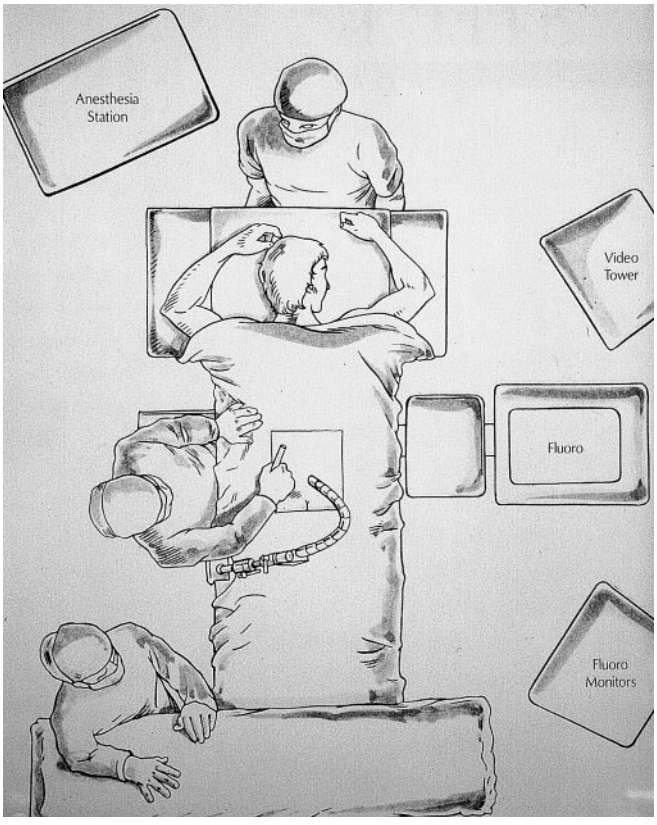

Fig. 3 A standard operating room set-up. The fluoroscope is necessary only at the beginning of the surgery and is then removed

Operating room set-up and patient preparation

The operating room should be of adequate size to accommodate the fluoroscopy unit, its monitor, and the video equipment for the endoscope. A microscope must be ready as well, in case of open conversion.

The C-arm fluoroscope is then positioned to obtain lateral fluoroscopic images of the operative lumbar interspace: note that in the lateral patient position, it is possible to get coronal images – very useful on some occasions (i.e., for the far lateral approach).

The surgeon stands on the side of the patient ipsilateral to the herniated disc (Fig. 3). A flexible arm assembly is attached to the operating table rail; this device holds the tubular retractor with endoscope in a stable position, freeing the surgeon's hands. Once the operative field has been prepped and draped, the lumbar midline is identified and a second line is drawn parallel to it, approximately 1–1.5 cm to the side of the disc herniation.

Standard instruments for microdiscectomy (rongeurs, Kerrisons, curettes, bipolar forceps) are used; they are only a little bit longer, and black, to prevent glare. For bone excision, a high-speed drill (Med-Nex or Midas-Rex) could be very useful, too.

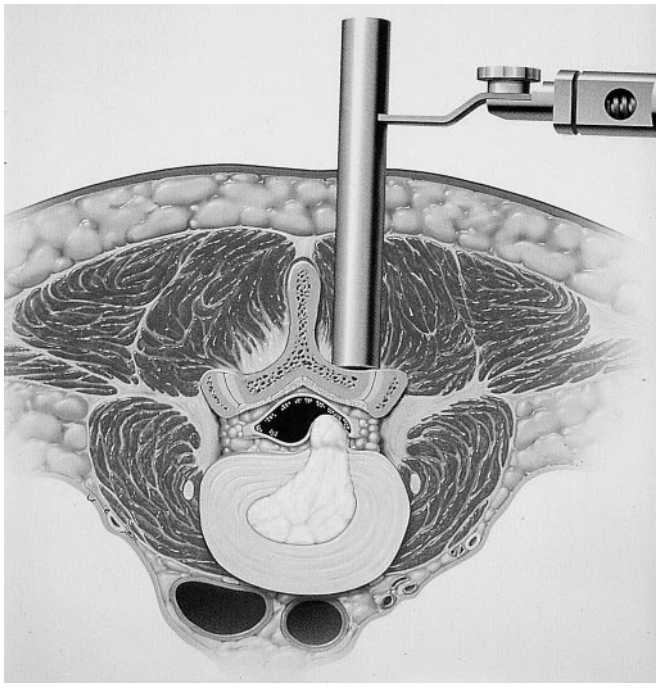

Fig. 4 The tubular retractor in place, held by the flexible arm. Note that the muscular attachments to the spinous process are intact

Incision and sequential soft tissue dilation

Under fluoroscopic guidance, a spinal needle is inserted and repositioned along this line at the level of the appropriate disc space. A 15-mm longitudinal incision is made, only into the superficial tissues, centered on the needle puncture site. A guidewire is then inserted through the small incision under fluoroscopic control, and directed toward the superior lamina. Three or four progressive cannulated soft tissue dilators are now put over the guidewire and each other. The first dilator is advanced through the lumbodorsal fascia until it is docked on the inferior edge of the superior lamina, and the guidewire is then removed. The surgeon can confirm proper placement of the dilator by lateral fluoroscopy in the sagittal plane, and by palpating the lamina with the tip of the dilator in the axial plane. In this fashion, just lateral to the base of the spinous process and just above the laminar edge, the correct positioning of the dilator is obtained. It is very useful at this point to scratch the lamina edge to free it from muscle attachments.

The other dilators are placed in sequential order over the first, to achieve a gentle dissection of the soft tissues and the fibers of the paraspinous muscles, leaving intact the lumbodorsal fascia and the muscular attachments to spinous process and to most of the lamina.

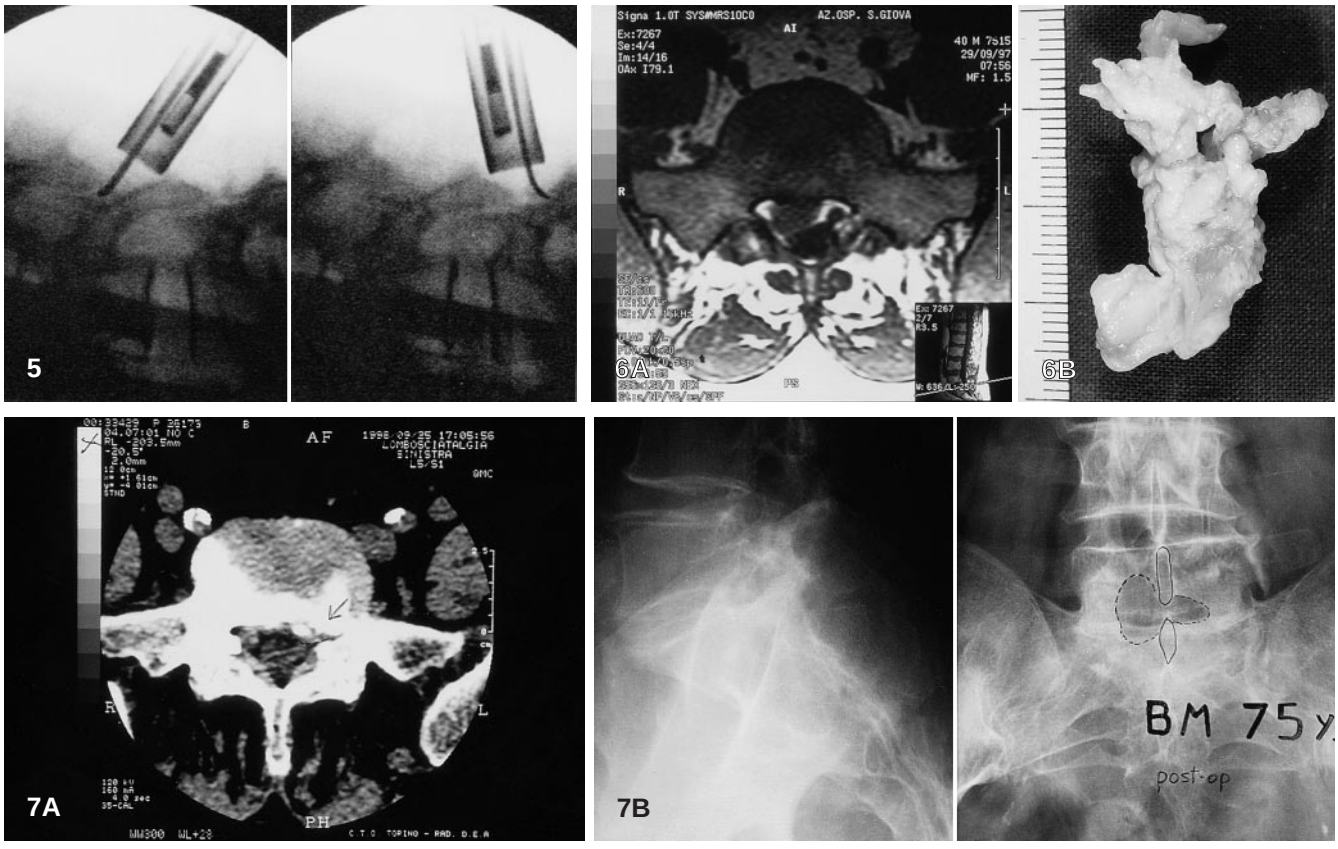

Fig. 5 Moving the tubular retractor in a cranial or caudal direction allows the "cone of work" to be easily expanded through the same small skin incision

Fig. 6 **A** Magnetic resonance (MR) imaging of a free fragment due to right L5-S1 extruded disc herniation. **B** The big fragment (3.5 cm), removed through the 1.6-cm skin incision

Fig. 7 **A** Example of lateral recess stenosis associated with left L5-S1 disc protrusion in a 75-year-old patient. **B** Postoperative radiograph, showing the monolateral partial laminotomy for decompression ("recalibrage") combined with the disc excision

Insertion of tubular retractor-endoscope and image orientation

The tubular retractor is advanced over the final dilator down to the lamina. Its proper positioning is confirmed fluoroscopically, and it is then connected to the flexible arm assembly to maintain its position and the operative field (Fig. 4).

After connecting the endoscope to the coupler/camera and to the light source, it is inserted into the tubular retractor and secured to it by a ring clamp. This allows the endoscope to be positioned anywhere around the retractor for 360° vision, and to be advanced or withdrawn for variable magnification. The suction tube defogs the endoscope lens, which, if dirty, can be cleaned with irrigation or by removing, wiping and reinserting the endoscope.

A key point for a correct surgery is the orientation of the video image when the endoscope is first inserted into the retractor, because the view on the screen must be similar to those commonly observed through a microscope. A proper image orientation occurs when the underlying anatomy shows the medial part on the top of the screen (12 o'clock) and the lateral one on the bottom (6 o'clock). This is accomplished by placing a surgical instrument in a lateral position and then rotating the camera/coupler until the instrument appears to be on the bottom of the video screen. With the new METR'x system, there is a much simpler way to do that, by repositioning a notch on the screen that corresponds to the position of the endoscope around the tube.

Laminotomy and flavectomy

After some soft tissue removal with a small rongeur and some hemostasis with a modified bipolar forceps, the inferior edge of the superior lamina is identified using a curette.

The ligamentum flavum is gently detached from the lamina, and generally a small laminotomy and/or minimal facetectomy is performed using a Kerrison punch or a modified high-speed drill (MedNext). In this fashion, adequate bone removal can be performed to address disc

pathology as well as lateral recess and/or foraminal stenosis. The ligamentum flavum is then opened using small scissors or a special protected knife, and then removed with a Kerrison rongeur.

By loosening the flexible arm, the tubular retractor can be repositioned in a more convenient way by "wanding" the tube, pivoted within the small skin incision. Using this maneuver, access from pedicle to pedicle can be accomplished through the initial 15-mm skin opening, acting into an inverted cone of work (Fig. 5). When the new position is reached, the flexible arm is tightened again, holding the tube in place.

Nerve root retraction and disc-bone removal

Once identified, the nerve root is exposed with a gentle epidural dissection, using some micro-instruments, like probes, dissectors or a fine suction-retraction tip. In this way, if necessary, the root can be retracted medially or explored in its axilla with modified retractor or ball-tip probe.

The authors like to perform a good undercutting of the medial facet to obtain a wide lateral recess opening and get an easy exposition of the nerve root. Free fragments or contained disc herniations can be identified in this fashion, and removed (Fig. 6). If an anulotomy is required, it can be performed with the microknife or microscissors.

The discectomy is then performed with pituitary rongeurs in a standard fashion, as usually done in a standard open microdiscectomy.

Afterwards, the root and dural sac are finally explored to check for any residual compression and/or retained disc fragments, controlling epidural bleeding, if significant, with the bipolar forceps.

In case of lateral or central stenosis, a wide segmentary monolateral laminotomy can be performed ("recalibrage") (Fig. 7), working on both laminae and foramen for a total nerve root decompression.

Closure

Before the final closure, the wound is irrigated with cold saline solution. At this point, the authors prefer to add some steroids and, in case of revision surgery, a gel-foam (ADCON-L Gel) to prevent recurrent scar formation in the re-opened canal.

The flexible arm is then loosened and removed, together with the tubular retractor. The paraspinous muscles "close" each other after this maneuver, resuming their normal anatomic position at the first post-operative contraction. The fascia is then closed with a single suture, the subcutaneous tissues with an inverted suture and the skin with Steri-strips.

Preliminary clinical results of the multicenter prospective study in Italy

Materials and methods

Sixty-eight patients with a minimum follow-up of 6 months were studied, out of a total number of 124 patients who underwent a MED procedure from November 1997 to the end of April 1999. The patient population consisted of 39 men and 29 women, aged from 21 to 77 years (mean age 40.8 years).

The operated disc levels were mostly L4-L5 (28 patients) and L5-S1 (37 patients), with only three cases at L3-L4. Most of the disc herniations were intra-canalar (3 median, 37 paramedian, 23 lateral), and only five cases were far lateral. No difference was seen with regard to side: 32 on the right and 36 on the left. About 40% of them had free fragments, while the others were protruded.

The surgery was performed under general anesthesia, in most cases (n = 42) in prone position, 18 in genu-pectoral position, and 8 in lateral position. Mean duration of surgery was 1 h (range: 35–150 min.), with a progressive reduction according to the learning curve.

Follow-up ranged from 6 to 19 months, with a mean of 13 months.

Results

Although our initial clinical results are preliminary, they are very encouraging. Using a modified STATUS Outcomes Assessment System, the results of the pre- and postoperative questionnaires, which were filled out by all the patients, prospectively assessed very good results. All patients had experienced substantial relief of their radiculopathy, and were discharged home within 18–24 h of surgery. The actual results show 94% had excellent or good outcomes (64 patients), only four patients had poor results at follow-up, due to persistent mild radicular pain in three and lumbago in one compensatory patient.

There were no complications, except for three small intraoperative cerebro-spinal fluid leaks, which did not require any open conversion, with the patients admitted for 2–3 days.

Clinical observation of the other 74 patients more recently submitted to MED or METR'x surgery confirm these results of the study cohort, although we can anticipate a slight reduction of good outcomes (from 94% to around 88%), due to more complex cases (such as revision cases) than those operated at the beginning of our learning curve.

Discussion

Our preliminary results are very similar to those reported by Foley and Smith [4] and confirm the reliability and versatility of MED/METR'x technique, especially compared to similar recently proposed systems for a percutaneous endoscopic approach to the spine.

At the beginning it was considered and applied as an alternative to standard microdiscectomy for lumbar disc

herniation, but nowadays we can perform many different posterior microsurgical procedures on the lumbar spine, all through the same small incision. Moving the tubular retractor with fulcrum on skin and lumbar fascia, it is possible to obtain a "cone" of work that makes it possible to address various posterior lumbar pathologies of the disc (herniations, protrusions), of the canal (lateral or segmental stenosis) and of bony structures (lamina, facet joint, foramen).

The efficacy of all these maneuvers is enhanced by the deep direct observation-magnification and the possible oblique visualization by means of the 25° angled endoscope, which can be turned around the tube as needed.

In our opinion, the key to performing these procedures in a safe and effective way is the initial correct positioning of the guidewire under C-arm control. It is essential to carry out careful preoperative planning, looking through X-rays and CT scans to analyze discal, canalar and bony morphology, and decide on the entry-point according to the surgical strategy.

The procedure benefits are a very short hospital stay, possibly on an out-patient basis, and very quick patient recovery, due to the minimal muscle and soft tissue disruption, the absence of sub-periosteal stripping and the negligible blood loss. Last but not least, the very small skin incision has generally an excellent long-term cosmetic outcome.

Conclusions

MED and now METR'x are unique systems for the surgical management of lumbar disc disease. Combining traditional lumbar microsurgical techniques with state-of-the-art endoscopy, they enable the surgeon to successfully address any kind of disc pathology and/or canal or foramen stenosis.

It is a true "video-assisted" mini-open "thru-a-tube" posterior lumbar spine surgery, whose limits of applications have probably not yet been discovered.

The smaller incision and lower muscle-soft tissue disruption compared with standard open microdiscectomy allow a faster recovery and return to work of patients. However, this does not imply any extension of surgical indications, or prevent the need for careful selection of patients suitable for surgery, as we are used to doing for open microdiscectomy.

Among the disadvantages of this technique, is the bidimensional vision, as for any endoscopic surgery, and a possible longer duration of surgery, particularly at the beginning of the learning curve. For these reasons we think that a specific skill in microsurgery and in endoscopic approaches is the best basis from which to begin the experience with MED/METR'x. It is also advisable to start with herniated free fragments in younger patients, and only later treat older patients with bony pathology associated with disc herniation.

Our own mid-term results, as well as those from other authors, are very positive and encouraging, and we believe that in few years the microendoscopic approach will become the new "gold standard" for lumbar disc surgery.

Furthermore, in the last few months, a direct evolution of MED has been introduced – the METR'x system – which is a comprehensive system for endoscopic posterior spinal microsurgery. Now the improved micro-instruments (black and glare-resistant, curved bipolar, suction-retraction ones, etc) and the better resolution of image with the new re-usable endoscope allow even easier and safer surgery, as the authors have experienced in their last 20 cases.

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